Glucose concentrations in parotid fluid and venous blood of patients attending a diabetic clinic[1]

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Summary: Measurements of the glucose concentration in venous blood and parotid saliva taken from 31 diabetics attending a diabetic clinic showed values ranging respectively from 3.9 to 19.1 mmol/l and 0.06 to 0.83 mmol/l (means 9.6 mmol/l and 0.32 mmol/l respectively). Linear regression of salivary glucose on blood glucose gave a simple correlation coefficient of 0.18 (NS). Since salivary glucose levels did not reflect blood glucose levels, the possibility of diabetics regulating their metabolic control by the noninvasive technique of monitoring salivary glucose concentrations is not possible.

Introduction

It is generally felt that normalization of blood glucose levels in diabetic patients reduces the risk of development of some of the specific complications of the disease. Attempting to control blood glucose by monitoring urinary glucose has the advantage of being noninvasive. The control achieved, however, is only approximate and the value of urine tests is restricted by the renal threshold to glucose which varies considerably between patients. Better control can be achieved by direct measurement of the blood glucose concentration, most conveniently achieved from a fingerprick sample, using Dextrostix (Sönksen *et al.* 1978).

The purpose of the present study was to investigate the relationship between salivary and blood glucose. If a close correlation were to exist, diabetic control could be monitored by the noninvasive method of measuring salivary glucose.

Materials and methods

Patients were recruited from the diabetic outpatients clinic; having consented to the procedures described below, patients were excluded from the study only if insufficient saliva was obtained for analysis. Of 43 patients, 12 were excluded for this reason (28%).

Pure samples of parotid fluid were obtained by cannulation of the parotid duct and suction applied with a sterile syringe. Salivation was stimulated by dropping lemon juice onto the tongue and external parotid massage when necessary. Samples were transferred to plain tubes and stored at $< 4°C$ until analysis (within 24 hours). Blood samples were obtained by venesection and placed in fluoride oxalate tubes. These were centrifuged, the plasma drawn off and stored at $< 4°C$.

The glucose concentration in both saliva and plasma samples were determined by the glucose oxidase method using a Beckmann glucose analyser. For plasma glucose determinations, 10 µl aliquots were used; for salivary glucose 10 µl, 20 µl or 50 µl aliquots were used, depending on the volume of saliva obtained.

The accuracy of sensitivity of the analysis was determined by measuring the glucose concentration in 10 µl, 20 µl and 50 µl aliquots from a pooled saliva sample (A). The effect of storage was tested by measuring the glucose concentration in 50 µl aliquots of another pooled saliva sample (B) after 1, 2, 3 and 4 hours at room temperature.

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Table 1. Mean of duplicate estimations of glucose concentration in venous plasma and parotid fluid in 31 diabetic patients

Patient number	Plasma glucose (mmol/l)	Salivary glucose (mmol/l)
1	14.6	0.19 ■
2	6.4	*0.10* ■
3	13.4	0.22 ■
4	11.6	0.41 ▲
5	13.0	0.28 ■
6	8.6	0.72 ■
7	6.3	0.14 ▲
8	5.8	*0.07* ▲
9	6.4	0.19 ▲
10	4.8	0.39 ▲
11	15.0	0.20 ▲
12	5.3	0.44 ▲
13	19.1	0.23 ▲
14	12.4	0.39 ▲
15	10.9	0.67 ●
16	5.9	0.11 ▲
17	11.2	0.11 ▲
18	4.6	*0.06* ▲
19	5.2	0.83 ●
20	10.6	0.32 ▲
21	7.0	0.67 ●
22	10.6	*0.33* ●
23	7.8	0.14 ▲
24	3.9	0.52 ▲
25	10.1	0.19 ▲
26	5.6	0.13 ▲
27	17.9	0.53 ▲
28	10.6	*0.14* ●
29	13.8	0.16 ▲
30	5.1	0.15 ▲
31	14.4	*0.19* ●

● = 10 µl, ■ = 20 µl, ▲ = 50 µl aliquots
The italicized values are below or around the detection sensitivity of the technique.

Results

Table 1 shows the mean of duplicate estimations of glucose concentration in venous blood and parotid saliva for 31 patients. Linear correlation of salivary glucose against blood glucose gave a correlation coefficient of 0.18 (NS, $0.3 < P < 0.4$). The sensitivity of the technique used for saliva was approximately 0.3 mmol/l with 10 µl aliquots, 0.15 mmol/l with 20 µl aliquots and 0.06 mmol/l with 50 µl aliquots. The salivary glucose concentration was below these values in two subjects (cases 28, 31), equal in one (case 18) and just above in three subjects (cases 2, 8, 22). Table 2 compares measurements on 10 µl, 20 µl and 50 µl aliquots of a pooled saliva sample (Subject A), and Table 3 shows glucose concentrations in 50 µl aliquots from another pooled sample (Subject B) over a four-hour period after collection. It can be seen that values are repeatable both between different aliquot samples and up to four hours after collection.

Discussion

The results show that salivary glucose concentration was independent of blood glucose concentration. This is in keeping with the findings of Campbell (1965), Von Mähr *et al.* (1968) and Mehrotra & Chawla (1968) who collected whole mixed saliva samples. Kjellman (1970)

Table 2. Salivary glucose concentration using different volumes of saliva (each sample measured in duplicate)

	Volume of saliva		
	10 µl	20 µl	50 µl
Glucose concentration (mmol/l)	0.61	0.56	0.52
	0.44	0.56	0.53

Pooled saliva sample from subject = (A)

Table 3. Effect of storage on salivary glucose (each sample measured in duplicate)

	Time after collection at 20 C			
	1 h	2 h	3 h	4 h
Glucose concentration (mmol/l)	0.28	0.33	0.27	0.32
	0.28	0.36	0.29	0.30

Pooled saliva sample from subject = (B)

Table 4. Comparison with other studies

Reference	Salivary glucose (mmol/l)			Method used for glucose estimation	Blood glucose (mmol/l)		No. of patients
	Range	Mean ± s.d.	Sample		Range	Mean ± s.d.	
Present study	0.061–0.83	0.32 ± 0.42	Parotid fluid	Glucose oxidase	3.9–19.1	9.6 ± 4.1	31
Campbell 1965	0.024–0.35	0.40 ± 0.42	Whole saliva (Centrifuged)	Glucose oxidase	No data		170
Shannon *et al.* 1960	0.022–0.064		Parotid fluid	Glucose oxidase	3.6–8.8		8
Von Mähr *et al.* 1968	0.0–0.8		Whole saliva (centrifuged)	Somogyi (photometric adaptation)	7.1–34.7		69
Kjellman 1970		0.32 ± 0.29	Whole saliva	Glucose oxidase		9.9 ± 1.1	15
Mehrotra *et al.* 1968	0.61–3.89		Whole saliva	Folin (colourimetric adaptation)	5.0–20.5		100
op. cit. Nondiabetic	0.61–3.33		Whole saliva		5.0–9.1		50
op. cit. Diabetic	0.61–3.89		Whole saliva		9.7–20.5		50
Kortuem 1944	0.11–3.61		Whole saliva (centrifuged)	Folin (colourimetric adaptation)	4.0–10.1		31

showed a correlation between blood glucose and gingival exudate but found no relationship with whole saliva. On the other hand, Mehrotra *et al.* (1968) did find a significant correlation between these two variables in female diabetics ($r < 0.69$) and male and female non-diabetics, while the study of Kortuem (1944) and Shannon *et al.* (1960) reported a rise in salivary glucose following the rise in blood glucose after a glucose load (oral and intravenous glucose loads respectively). Table 4 compares our own findings with those of other workers. In all but Shannon's and the present study whole saliva was sampled. In the studies of Kortuem, Campbell and Von Mähr, saliva was spun before analysis. In the largest study (Campbell 1965), only 56.8% of normals and 66.7% of diabetics had measurable glucose, whereas glucose was definitely detectable in all but 3 of our subjects (10%) where values recorded were equal to or below the detection sensitivity of our methods.

The variability in the results of different workers may be a reflection of different population samples, different sampling techniques for collecting saliva or the various methods used for glucose analysis. By parotid duct cannulation the complication of mouth contaminants in the saliva was eliminated in this study – something which cannot be ruled out in all but the study of Shannon *et al.* (1960). This is particularly critical with the low values of glucose present in saliva.

It must be concluded that any correlation that has been reported to exist is so weak that it can be of no clinical use in aiding diabetics to regulate their metabolic control.

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